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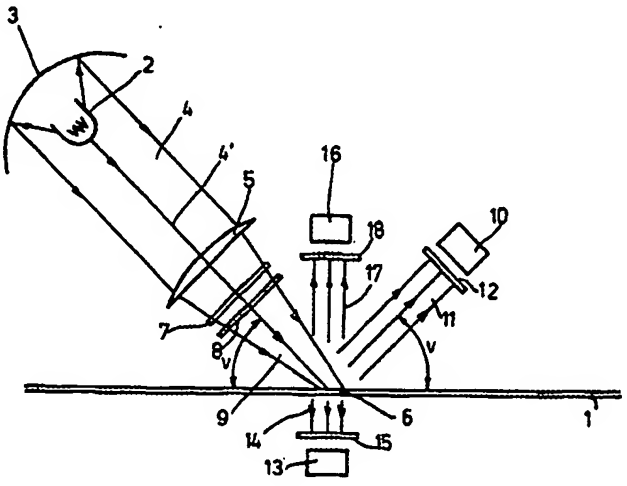

(57) Abstract

A dollar bill (1) to be tested is illuminated by a pencil of rays (9) of ultraviolet light having an angle of 45°. A first part Φ_1 of the light reflected by the bill and having a wavelength $\lambda < 400$ nm is detected in a photodetecting device (10). A second part Φ_2 of the light passing through the bill and having a wavelength $\lambda = 340$ nm, approximately, is detected in a photodetecting device (13), and a third part Φ_3 of the light emitted from the bill by the effect of fluorescence and having a wavelength in the range $426 < \lambda < 446$ nm is detected in a photodetecting device (16). The three parts of light Φ_1, Φ_2, and Φ_3 are compared in an electric circuit to predetermined values referring to a genuine bill. If disagreement exists between at least one of the measured values and the predetermined values, a signal is emitted indicating that the bill is forged. The possible organic differences in the manufacturing material between a tested bill and a genuine bill may be proved with certainty, and thus whether the tested bill is genuine or forged.

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METHOD FOR TESTING OF BANK NOTES, ESPECIALLY DOLLAR BILLS, AND EQUIPMENT FOR THE IMPLEMENTATION OF THE METHOD

The present invention concerns a method for testing bank notes, especially dollar bills, by which a note to be tested is illuminated by a pencil of light rays from a halogen bulb.

Generally speaking, the American currency has not changed its appearance from 1926 until today. There are only a few safety elements in this currency. It does neither have a watermark nor a safety thread. As a consequence, counterfeiting of this very currency has been extensive through the years and is still increasing. With modern techniques it is presently easy to make dollar-copies of great likeness.

The genuine dollar bill is made from fibres of cotton and flax bonded by polyvinyl alcohol. Forged bills may be made of wood-based fibres or from different combinations of textile fibres, which generally deviates from the material structure of the real bill.

From the applicants' Danish patent application no. 1208/94 there is known a method and an apparatus for testing dollar bills. But this method implies a little margin of a few percent where it cannot be decided with certainty whether the bill is genuine or forged.

It is an object of the present invention to provide a method by which it may be decided with certainty whether a dollar bill is genuine or forged. This is attained by a method according to the characterizing part of claim 1.

By this method it is possible to show the organic differences in the manufacturing material between a genuine and a forged dollar bill with greater certainty and thereby to decide with great certainty whether a bill is genuine or forged.

Claim 2 concerns preferred wavelength ranges for the different parts of light used by the method according to the invention.

The present invention also concerns an equipment for the implementation of the method according to the invention.

Claim 3 concerns such an equipment.

Claim 4 concerns a source for ultra-violet light for use in an equipment according to the invention.

Claim 5 concerns an electric circuit, which forms a part of an equipment according to the invention, and claim 6 concerns a signal emitter, which forms a part of an equipment according to the invention.

The invention will be described in detail in the following with reference to the drawing, where

Fig. 1 shows in principle an equipment for testing of bank notes by the method according to the invention, and

Fig. 2 shows schematically an electric circuit to be used in an equipment for testing bank notes by the method according to the invention.

As shown on Fig. 1 a bank note or bill 1 to be tested is illuminated by a halogen bulb 2, which is placed in the focus of a reflecting mirror 3, whereby a pencil of rays 4 is emitted.

The halogen bulb 2 is situated in relation to the bill 1 so that a center line 4' in the pencil of rays 4 form an angle v, preferably 45°, with the bill 1. Between the

halogen bulb 2 and the bill 1 there is mounted a planoconvex lens 5, that focuses the pencil of rays 4 on a spot 6 on the bill 1. The lens 5 is designed in such a way and/or situated so that the spot 6 has a diameter of about 10° mm. After the lens 5, as seen in the direction of the rays, there is placed a first filter 7 for filtering off infrared light and a second filter 8 for filtering off visible light, so that the pencil of rays 9 hitting the bill consists of ultra-violet or UV-light. A part Φ_1 of the pencil of rays 9 of UV-light hitting a bill is reflected by the bill with an angle v. Another part Φ_2 of the pencil of rays 9 passes through the bill, and a third part Φ_3 is absorbed by the bill.

The portion of UV-light absorbed by the bill material creates a flourescence-effect in the visible light spectre. This effect varies much as a consequence of the organic composition of the material. Also the presence of non-organic compounds as bleaching agents cause a strongly varied flourescence effect. The effect of flourescence may be explained in this way: When organic/non-organic material is hit by UV-photons from the light source, loose electrons are excited away from the atomic nucleus. The electrons, however, quickly return to their original orbits, and by this return they emit light with a longer wavelength. The light is usually recovered in the visible blue-violet range.

The three light parts Φ_1, Φ_2, and Φ_3 are measured/registered in the following way.

As shown in Fig. 1 a photodetecting device 10 is placed in such a way over a bill to be tested, so that it is hit by a pencil of rays 11 of light reflected from the bill. Before the photodetecting device, as seen in the direction of the rays, there is mounted a filter 12, which only allows light with a wavelength of $\lambda < 400$ nm to pass.

Another photodetecting device 13 is situated in such a way under the bill, that it is hit by a pencil of rays 14 of light passing through the bill. Before the photodetecting

device 13, as seen in the direction of the rays, there is mounted a filter 15, which only allows light with a wavelength λ equal to about 340 nm to pass.

A third photodetecting device 16 is situated in such a way over the bill, that it is hit by a pencil of rays 17 emitted from the bill by the effect of flourescence. Before the photodetecting device, as seen in the direction of the rays, there is mounted a filter 18, which only allows light with a wavelength in the range 426 nm $< \lambda <$ 446 nm to pass.

As shown on Fig. 2 the three photodetecting devices 10, 13, and 16 form part of an electric circuit, where they are connected to an amplifier each, 19, 20, and 21, respectively. These amplifiers transforms the incoming signals up to a desired level, and they are connected to a comparator each, 22, 23, and 24, respectively, in which the incoming signals are compared to a set value, Φ_1', Φ_2', and Φ_3', respectively, whereby there is produced the answer(s) yes/no, over/under, or +/-. The comparators 22. 23, and 24 are connected to a logical circuit 25, which is connected to a signal emitter, which may consist of a first light emitter, for example a green one, that is lit if a tested bill is genuine, and another light emitter 27, for example a red one, that is lit if the tested bill is forged, and of a sound emitting device 28, which emits an audible signal, when a tested bill is forged.

The equipment as shown and described above is only an example of equipment, which may be used for implementing the method according to the invention. Within the scope of the invention other embodiments may be envisioned. For example, the signal emitter may be made in another way.

PATENT CLAIMS

1. A method for testing bank notes, especially dollar bills, by which a bill (1) to be tested is illuminated by a pencil of rays (4) of light from a halogen bulb (2), c h a r a c t e r i z e d in that the bill (1) to be tested is irradiated with ultra-violet or UV-light, that the pencil of UV-light rays (9) hits the bill at an angle (v), that preferably is 45°, that a first part (Φ_1) of the light reflected by the bill (1), a second part (Φ_2) of the light passing through the bill, and a third part (Φ_3) of the light absorbed by the bill are registered and compared with a set of predetermined values (Φ_1', Φ_2', and Φ_3', respectively), and that in the case of agreement between the registrered values (Φ) and the predetermined values (Φ') there is emitted a signal indicating that the bill (1) is genuine, and that in the case of disagreement between at least one of the registered values (Φ) and the predetermined values (Φ') there is emitted a signal indicating that the bill is forged.

2. A method according to claim 1, c h a r a c t e r i z e d in that the first part (Φ_1) is filtered and has a wavelength $\lambda < 400$ nm, that the second part (Φ_2) is filtered and has a wavelength λ approximately equal to 340 nm, and that the third part (Φ_3) is filtered and has a wavelength in the range $426 < \lambda < 446$ nm.

3. An equipment for implementing the method according to claim 1, c h a r a c t e r i z e d in that the equipment comprises a source of UV-light, that may emit a pencil of rays (9) against the upper side of a bill (1) to be tested, the rays having an angle (v) in relation to the bill; a first photodetecting device (10), that is situated in such a way above the bill, so that the device is hit by a pencil of rays (11) reflected by the bill (1), and before the photodetecting device (10), as seen in the direction of the rays, a filter (12); a second photodetecting device (13) that is situated in such a way under the bill, that the device may be hit by a pencil of rays (14) passing through the bill, and before the photodetecting device (13), as seen in the direction of the rays, a filter (15); and a third photodetecting device (16), that is situated in such a way

above the bill, so that the device may be hit by a pencil of rays (17), that is emitted from the bill by effect of flourescence of the part of the rays (9) absorbed by the bill, and before the photodetecting device (16), as seen in the direction of rays, a filter (18); which photodetecting devices (10, 13, and 16) are connected to an electric circuit, that is able to emit a signal indicating whether the tested bill is forged or genuine.

4. An equipment according to claim 3, characterized in that the source of UV-light comprises a halogen bulb (2), a reflecting mirror (3), a planoconvex lens (5), a first filter (7) for filtering off infrared light and second filter (8) for filtering off visible light.

5. An equipment according to claim 3, characterized in that the three photodetecting devices (10, 13 and 16) form a part of an electric circuit where they are connected to an amplifier each (19, 20, and 21, respectively), that transform the signals from the photodetecting devices up to a desired level, which amplifiers are connected to a comparator each (22, 23, and 24, respectively), that compare the incoming signals with a predetermined value, and e.g. emit a "yes/no" signal, which comparators are connected to a logic circuit (25) wherein the incoming signals are processed, and which is connected to a signal emitter.

6. An equipment according to claim 3, characterized in that the signal emitter consists of a light emitter (26), e.g. a green one, that is lit when a tested bill is "good", another light emitter (27), e.g. a red one, that is lit when a bill is "false", and possibly a signal emitter (28) for emitting an audible signal, that is connected to the other light emitter (27).

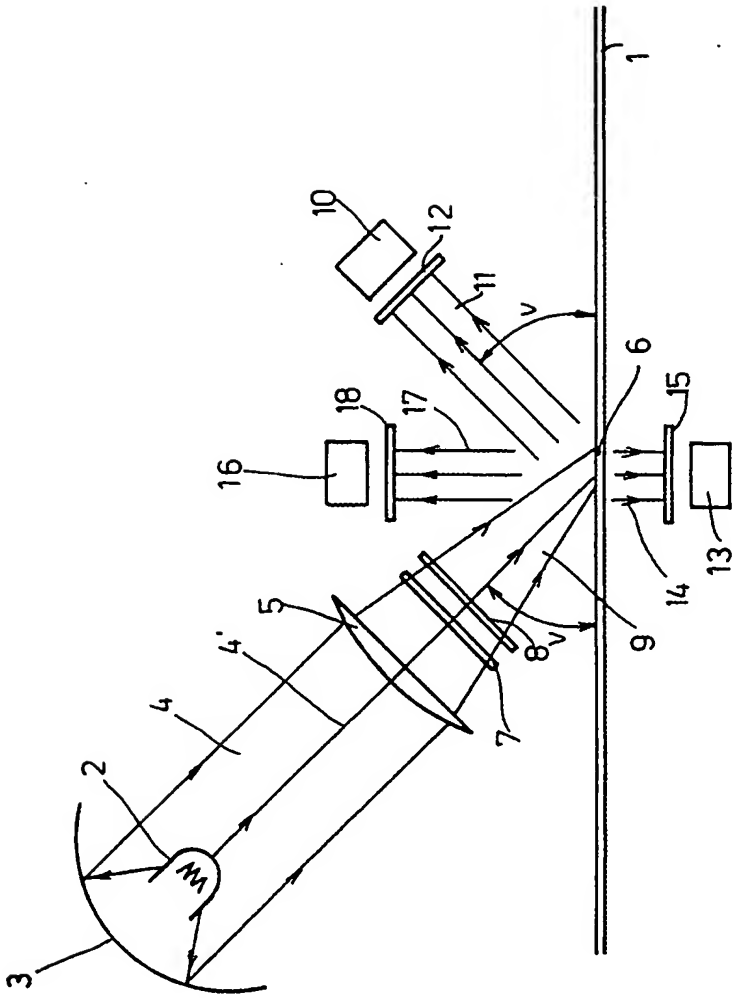

FIG. 1

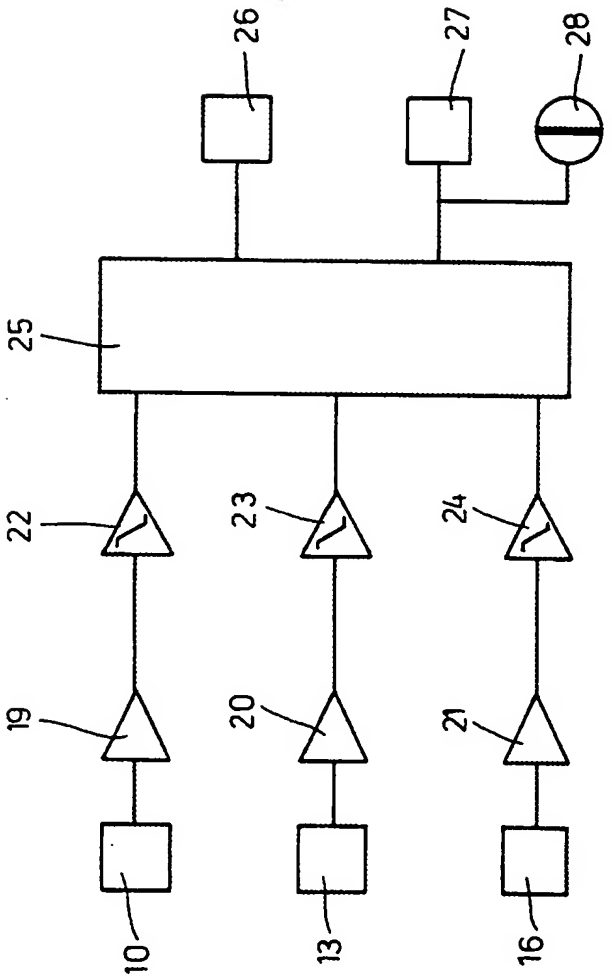

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 96/00260

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: G07D 7/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: G07D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9416412 A1 (PRIZEGUARD ASSOCIATES LTD.), 21 July 1994 (21.07.94) --	1-6
A	EP 0537431 A1 (LANDIS & GYR BUSINESS SUPPORT AG), 21 April 1993 (21.04.93) --	1-6
A	SE 455547 B (ARNE BERGSTRÖM), 18 July 1988 (18.07.88) --	1-6
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☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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9 October 1996	11.10.96
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INTERNATIONAL SEARCH REPORT

Information on patent family members

05/09/96

International application No.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		AU-A- 3508593	13/09/93
		AU-A- 5820094	15/08/94
		EP-A- 0626891	07/12/94
		EP-A- 0679279	02/11/95
		JP-T- 7503905	27/04/95
		JP-T- 8505253	04/06/96
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		GB-A,B- 2122743	18/01/84
		SE-A- 8303525	30/12/83
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